The
urrent Significance
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ALUM

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THE CURRENT SIGNIFICANCE OF THE WORD "ALUM."

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The Current Significance of the Word ALUM

By

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With

References to the Literature

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Preface

AUSTIN M. PATTERSON, Ph.D., has written and published a pamphlet entitled "The Meaning of the Word 'Alum,'" in the course of which he discusses the derivation, the early history, the two meanings of the word as now understood, and develops a third meaning which he proposes to introduce into current dictionaries. Dr. Patterson has taken great pains in looking up authorities and his presentation is a scholarly one. The bibliography of the subject which he has worked up is extensive and the quotations which he introduces are correct. But the writer of this brochure must take issue with Dr. Patterson's conclusion as to the advisability of extending the significance of the term "alum" beyond its present confines. In such an extension there is involved not only the case under consideration but the matter of general chemical terminology and it, therefore, becomes of considerable moment and reaches beyond the limits of the immediate issues involved. The author is indebted to Dr. Patterson for many references and takes this opportunity to express his appreciation of the pains-taking way in which Dr. Patterson has investigated the early, middle and recent history of alum. Dr. Patterson and I agree with reference to our authorities but we differ widely in our conclusions.

W. D. R.

The Current Significance of the Word "Alum"

THE question at issue here is whether the meaning of the word "alum" shall be maintained in its commonly accepted sense and in conformity with general chemical usage with respect to other chemical substances and compounds, or extended so as to include salts and substances which are not properly embraced within the term "alum" or "the alums," such as aluminium sulphate and dry sodium aluminium sulphate. Indeed, it has been urged that the scope of the word be so enlarged as to include aluminium sulphate in any form whatsoever. In itself such an extension might be considered to be relatively unimportant; but as a precedent in somatics it might lead to a confused state of affairs in chemical terminology. If a word denoting a definite chemical substance and a group of compounds closely related chemically and crystallographically may be extended to include other substances, nothing short of misunderstanding will result. Under such a system if "alum" were written, the reader would have no means of knowing whether alum were intended, or one of the alums, or aluminium sulphate, or dry sodium aluminium sulphate or what form of combination or mixture of aluminium sulphate. No good reason has been advanced for such an extension. The only reason suggested is that some engineers and laymen have so used it. Fortunately, chemists are still arbiters of their own terminology.

SIGNIFICANCE OF WORDS

The significance of words is determined primarily by the principle of present good use and not by past use or derivations and roots in the classical languages. The usage of words which have a scientific or technical significance is and must be restricted more rigorously

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than words of every-day significance and ordinary usage. Great as the interest may be in the ancient use and the derivation of words, and it must be acknowledged that this interest to the student, the historian and the lexicographer is often of the highest order, such use and such derivation do not determine current usage and significance.

The word "alum" has passed through several changes in meaning, starting with the Latin alumen (still used in pharmacologies and pharmacopoeias) from Roman to modern times. The Greek στυπτηρία which is commonly considered the equivalent of the Latin alumen, is only of co-relative interest to us so far as the word "alum" is concerned. It is preserved in the English word "styptic" which, in its modern meaning, keeps fairly close to the ancient significance of στυπτηρία, an astringent substance (comp. στυπτικός, στύφειν).

The ancients were limited in their identification of chemical substances to such means as the source, the appearance, organoleptic tests, such as taste and smell, and the action of the substance when put to its usual or practical use; but chemical tests in the modern sense were few in number and systematic methods of testing and analysis were unknown. This accounts for the confusion of substances which may have had one or several properties in common, in the ancient mind and literature. Although in modern science many Greek, Latin and Arabian words and roots are retained, the meanings have been restricted and made definite so that in our modern scientific lexicons and general dictionaries the confusion resulting from the application of one word to several specific things or genera is reduced to a minimum. This is as it should be for otherwise intercommunication between scientific men would be as confused and meaningless as the gibberish of the alchemists or the chatter of the medieval mystics. Science also claims the right to define words which properly belong to it although they may be in general use. Trade jargon and shop-talk may be satisfactory and even useful when restricted to particular industries and groups of workmen, but the general use of words and phrases of such an origin should not be given wide usage without suitable restrictions.

ANCIENT DERIVATIONS DO NOT DETERMINE THE SIGNIFICANCE OF MODERN WORDS

The interest of the student in the derivation and evolution of words is of the same sort as the interest of the scientist in the evolution of animal and plant forms, but the ancient form either of words or living species does not necessarily or usually define the modern meaning or species. The evolution of the bird from the reptile is of the greatest biological interest, but the reptile does not define or determine the bird. The derivation of the word "alcohol" from the Arabic "el-kohl" or "al-kuhl," the black pigment used to darken the eyebrows and eyelashes of ancient Egyptian beauties, through the various meanings, a black powder, a dust, a vapor, a distillate, a distilled essence, *the* distilled essence—alcohol—is of vast and romantic interest, but el-kohl in no wise defines alcohol. The missing links in word derivations may be quite as great as in the evolution of organic forms. Nor do books tell the full story of words. There are numerous gaps. During such hiatuses words were undergoing changes in the mouths of the uneducated common people to be picked up later by the learned and the makers of lexicons. The sequences in word significance are accidental, adventitious, opportunistic. The evolution of language follows no rule or order. For the majority of words in common and literary use, illiteracy was the chief agent of change. Hence, the necessity for emphasis on present day good use.

The comparative simplicity of life and thought in ancient times as contrasted with the complexity of modern life, accounts for the fact that one word might suffice then, where a dozen are necessary now. The so-called elements, earth, water, air and fire sufficed for the ancients or formed the content of a sufficiently imaginative hypothesis, whether of elements or properties of matter, or a vague combination of the two, whereas it requires ninety-two distinct elements (true elements), not to speak of isotopes, of definite properties, and now even of planetary constitution, to satisfy the modern scientific mind. Alumen might very well have answered in Roman times for any astringent substance with specific reference to potash alum, but it could not serve in that sense today since chemistry has discovered innumerable astringent substances and determined their exact composition. Modern scientific words of new invention have a precise meaning although sometimes they too undergo change. Their fixity is of a higher order than that of words in common use for the purposes of literature, talk and badinage. Scientific good use must determine the current meaning of scientific and technical words just as literary good use determines the meaning of other words. The proper course of the modern scientific lexicographer is toward precision, not looseness, in the definition of words. Precision, accuracy and specificity should be the guides. If all the waifs and strays of trade jargon and common usage were adopted into the family of words, the dictionaries would be filled with gibberish. Occasionally an orphan may be adopted into the family and made respectable but only with due circumspection, and after most careful consideration.

DERIVATION OF THE WORD "ALUM" AND ITS EARY HISTORY

The Latin alumen, still used by the medical fraternity, from which the English word "alum" is derived, has been associated with the Greek word ἅλς (salt) (Charles Richardson's New Dictionary of the English Language, London, 1838) and has been compared by other authorities with the Greek ἄλοιμα, (ἄλειμμα) signifying unguent (Harper's Latin Dictionary, Oxford

1880). Again, these words are associated with the Greek ἀλοιφὴ signifying anything with which one can smear or anoint.

The latin word *alumen* was applied to several substances, both in the solid state and in solution, characterized by a marked astringency. Pliny states (Bostock-Riley Transl. Book XXXV), "The leading property of every kind of *alumen* is its remarkable astringency to which in fact it is indebted to its name with the Greeks" (στυπτηρία a styptic or astringent substance). All varieties of *alumen* had their origin in brines exuding from the earth. After crystallization some of these solutions produced a white *alumen*, others products of a slightly darker color, but Pliny remarks that the actual difference in color was trifling in reality compared to the effects produced in dyeing, the white alumen being employed for dyeing wool with bright colors and the dark for giving the wool a tawny or drab tint. Aluminium sulphate, ferrous sulphate and alkali sulphates were probably among the principal constituents of these natural alum brines. Thus, it would appear that among the substances embraced in the Greek word στυπτηρία and the Roman alumen were ferrous sulphate, aluminium sulphate, and on account of its ability to crystallize readily, potash alum, and mixtures of these in various proportions with other saline impurities. Apparently alumen brines were in use quite as much as the solid products of crystallization.

> "Under στυπτηρία or *alumen* of the Ancients must be understood substances of astringent properties generally, although alum itself is what is usually meant; being prepared from alum shale, it contained green vitriol as an impurity." Meyer, History of Chemistry, tran. McGown, London (1906), p. 19.

> "Among the salts which were already known in Pliny's time, and whose properties were carefully investigated by the alchemists, alum

and some of the vitriols deserve special mention, the former being obtained in various places from alum shale. The pseudo-Geber tells us how to purify it by re-crystallization from water, and terms it *alumen de rocca* (from the name of its chief source, the town Roccha), a term which long remained in vogue in France as alun de roche. The fact that alum contained an alkaline salt was overlooked, and its true composition remained unknown; alum itself, however, was early made use of as an astringent and styptic (cf. Abu Mansur.)” Ibid., p. 55.

“Aluminium: The name of this metal is derived from *alumen,* alum. This, as well as the corresponding Greek word στυπτηρία was originally used to designate very different bodies, all of which possessed the common property of an astringent taste. There can, however, be little doubt that alum itself was included amongst these bodies, and this salt was well known to the Latin Geber and the later alchemists, being, however, classed amongst the vitriols, until Paracelsus showed that it differed from this last family of salts. In his second treatise, *De Generibus Salium,* he states: “Alum is in no wise connected with the metals, but is a salt, standing alone in the acid, and taking its *corpus* from the intermixture of the earths; vitrioil does not do so, but solely from the intermixture of metallic corpora. The nature of the earth, which is combined in alum with sulphuric acid, remained long undetermined. It was usually supposed to be a calcareous earth, although it was noticed in the seventeenth century that clay, when treated with sulphuric acid, gave an alum: and hence Pott, in his *Lithognosy,* published in 1746, stated that the basis of alum was an argilla-

> ceous earth. It was not till 1754 that Marggraf showed that alumina differed totally in its properties from lime, and that clay contained this earth, combined with silica." (Roscoe and Schorlemmer, Treatise on Chemistry, Vol. II, London, 1923, p. 730).

Thus it would seem from a reasonable interpretation of the Greek and Roman authorities that among the substances included under στυπτηρία and alumen that alum in the modern sense, that is potash alum, was included. It should be remarked that the στυπτηρία alumen of the ancients, whatever specific substance might have been designated by this name, was always a natural mineral product, originating chiefly in regions producing alum stone or alunite, and never denoted an artificial or manufactured product. Thus, ammonium alum is in all likelihood excluded from the conception of the Greek stypteria and Roman alumen.

It is not impossible that even in early times crude methods of purification, and even recrystallization, were employed but such processes are not given consideration by the older writers such as Dioskorides and Pliny. However, purification processes did develop later and Geber, among the Arabian writers (circa 700 A.D.), was well acquainted with a pure alum which he calls "ice alum," presumably from its clear crystalline aspect, the preparation of which he describes by recrystallization from the impure product derived from Roccha (probably the classical Edessa) in Mesopotamia. The modern French expression, alun de Roche, signifying alum, has come down through the ages from the ancient Mesopotamian town of Roccha which now lies buried under sand, even the site all but forgotten. It is reasonable to suppose that, if we were in possession of all the facts, the history of alum would appear to have taken a direct course from ancient times to the present and that the crystalline substance, alum, in reasonably pure form has been known by those to whom it was of most interest, either students, professional men or artisans from very early times to the present day. The reasonableness of this view is based not only on the records, which are somewhat confused, but also on the properties of alum itself, its ease of crystallization, its large and interesting crystal form, its pronounced astringent effect and its utility in dyeing and tanning. It is most unlikely that a chemical and crystalline species of such pronounced properties would have been overlooked by ancient craftsmen, even though it remained undescribed in precise terms by the superior class of philosophical but non-experimental scientific men of those times.

AMMONIUM ALUM

The date of the invention of ammonium alum is lost. It is impossible to say within a century, or perhaps even several centuries, when this variety of alum was first discovered and prepared. As shown above, the alum of the ancients was derived from natural mineral sources such as incrustations and astringent brines. Ammonia derived from stale urine has always been known to mankind or, at any rate, since containing vessels were first invented, and has been used as a detergent all over the world. It was in very general use in ancient Egypt, Greece and Rome. Had the alum of the ancients been more definitely a manufactured product, it is conceivable that ammonia derived from stale urine (eant) might have entered into its composition, but there is no evidence that this was the case. Ammonium alum does not positively appear in the history of chemistry until the iatro-chemical period or, say, after the year 1500 when Ernst von Meyer (History of Chemistry, Page 99) believes that the principal variety of alum manufactured and used was ammonium alum.

> "Lime and alum earth (alumina), for instance, were supposed to be pretty much the same. Of their salts, alum—prepared by adding putrefied urine to the crude alum lye (the aqueous extract from roasted aluminous shale)

> —was much prized for its technical value, and was manufactured in large quantity; the alum of that day was thus essentially ammonia alum." (Meyer, History of Chemistry, tran. McGowan, London (1906), page 99.)

From that time on both common alum and ammonium alum were manufactured while sometimes the one and sometimes the other predominated, according to the relative price of potassium salts and ammonium salts respectively. James states in his Medical Dictionary of 1743:

> "Formerly, and even now, in places where they boil Alum, instead of Pot-ash, they use human Urine putrefy'd, because of the Urinous volatile Salt, by which the redundant Acid was temper'd; but since the Invention of so Cheap and Easy an Expedient, Urine is no longer used."

The following table gives a rough picture of the vicissitudes of the two substances in our era:

Various astringent salts, including common alum (potassium alum) were included in the term στυπτηϱία of the Greeks and alumen of the Romans until some time in the present century. Geber was the first or among the first to distinguish common alum as "ice" alum (700 A. D.)	700
Common alum (potassium alum) was the common alum to about	1500
Ammonium alum manufactured (James' Medical Dictionary, 1743)	1500-1743
Potassium alum manufactured	1743-1845
Ammonium alum manufactured (ammonium sulphate from gas works, 1845)	1845-1865
Potassium alum manufactured (Stassfurt salt deposits worked, 1865)	1865-1914

Ammonium alum manufactured (The Great War, 1914-1918)	1914-1920
Potassium alum, commonly made	1920-

The above table represents only an approximation and the fact should be kept in mind that potassium alum has been the common and prominent alum of all periods and has been manufactured either in very large quantities or moderate quantities from olden times. Ammonium alum was its competitor and substitute and occupied a prominent place among chemicals during certain periods, but it is not likely that the manufacture of potassium alum ceased altogether even then. Is it possible to say that there was not an element of falsification or adulteration in the first substitution of ammonium alum for potassium alum because of the cheapness of ammonium salts and the comparative costliness of potash salts? Are we to suppose that the general buying public or even the more technically trained, such as physicians and pharmacists, were made aware of the change in composition by the manufacturers? Was not the substitute sold under the phrase "just as good" or perhaps with no explanation or excuse at all? This is what we should expect. The contrary supposition would require a great and altruistic difference between the people of this age and those of the iatro-chemical period, which is unwarranted by history and far from believable. Fortunately, as an astringent, ammonium alum is quite as good as potassium alum although if some other property were in question ammonium could not be considered the equivalent of potassium.

ALUM AND AMMONIUM ALUM

Of these two alums, common alum (potassium alum) has unquestionably the oldest history and has been on the whole better and more commonly known than ammonium alum. Ammonium alum developed from a manufacturing process which consisted in adding decomposed urine to roasted alum shale, lixiviating the product, evaporating and crystallizing, or adding the decomposed urine to the lixiviate from the shale; whereas the alum of the ancients was either a natural brine, an evaporated natural brine or, somewhat later, a product resulting from the purification by crystallizing of a natural brine or salt mixture of natural origin. When manufacturing processes for alum were first used, the source of the raw material was of a mineral nature, particularly alunite or alum stone containing no ammonium, ($K_2O\ 3Al_2O_3\ 4SO_3\ 6H_2O$ or $K\ (AlO)_3\ (SO_4)_2\ 3H_2O$). Thus it is likely that alum (common alum, potassium alum) became a fairly well-known chemical and drug in late Roman times and in the Middle Ages because it had the essential astringent properties of the group of substances previously comprised under the term alumen and because it could be readily purified by crystallization. This does not eliminate the possibility of confusion of substances, particularly among the less discerning or the less learned, during the middle ages, when chemical analysis was unknown, and confusion of thought the rule rather than the exception, and irrational and illogical belief the fetish and the obsession of the majority. In particular, the old confusion of astringent substances persisted to some extent, so that iron vitriol (ferrous sulphate $FeSO_4 7H_2O$), especially in dehydrated form, was sometimes mistaken for alum, but to a less extent than with the Greeks or Romans.

This conception of alum (i. e. potassium alum) has held to the present day and the only extension of the term has been to cover substances of a similar chemical nature and crystallographic form in which potassium might be replaced by ammonium, sodium, rubidium, caesium, etc. and aluminium by iron, chromium and other metals.

ALUM IN ITS PRIMARY SENSE

After the vague conceptions of the ancients concerning astringent substances comprised under the terms στυπτηρία and alumen had focused on the most prominent crystallographic member of that group, namely, potassium alum, and in particular when later this was analyzed and assigned a definite composition and formula, potassium alum became *the* alum of chemistry and commerce. Ammonium alum was its substitute during those periods when ammonia or ammonium salts were cheaper or more conveniently obtainable than potassium salts and sodium alum never reached the importance of being a competitor of either of the others—in fact, may be regarded still as a chemical curiosity. The word "alum," unqualified, has signified potassium alum, $K_2 Al_2 (SO_4)_4 .24H_2O$, to lexicographers and chemical and medical writers in the great majority of cases. Although ammonium alum has occupied a prominent place in pharmacy in competition with common alum, and although at certain times it has been on an equal basis and sold interchangeably with the latter, historically it must be assigned a second place and looked upon as a substitute for potassium alum.

It is acknowledged by Dr. Patterson that practically all modern authorities agree that the word "alum" in its restricted and primary sense signifies crystalline potassium alum. These authorities include textbooks of general chemistry, of industrial chemistry, medical dictionaries and general dictionaries, quotations from some of which are included further on. Among the general dictionaries which so define alum are Webster's New International, Funk and Wagnalls' Standard, The Oxford English Dictionary, The Concise Oxford, etc. etc. Among the medical dictionaries are Gould's and Dorland's. The U. S. Pharmacopoeia of 1907 defined alum as potassium alum. The British Pharmacopoeia has generally included both potassium alum and ammonium alum under the term "alum" and later editions of the U. S. Pharmacopoeia (after 1907) follow the same practice. The U. S. Dispensatory also considers that the word "alum" means either potassium or ammonium alum and states that

> "The name alum has been applied indifferently to two salts, one consisting of aluminium trisulphate combined with ammonium sulphate, the other of the same salt of aluminium combined with potassium sulphate, and distinguished as *ammonium alum* and *potassium alum.* The former was official in the U. S. P. 1870, but was replaced by potassium alum. *Ammonium alum* is still retained with potassium alum under the title *Alumen* in the United States and British Pharmacopoeias."

But there must have been a lingering doubt about the propriety of the double sense of the word, for the author goes on to state

> "AMMONIUM ALUM. *Aluminium* and *Ammonium Sulphate.* — Besides the potassium alum, there are several others, in which the potassium is replaced by some other base, as, for example, ammonium or sodium."

The 1916 U. S. Pharmacopoeia states "the label of the container must indicate whether the salt is Ammonium Alum or Potassium Alum."

In fact the only authoritative departure from the correct use of the word "alum" appears to be in pharmacy and this only as a matter of convenienec without regard to chemical terminology; but the pharmacists have never extended the meaning of alum so as to include aluminium sulphate or sodium aluminium sulphate.

There are also a few other exceptions to the general rule, chiefly among older writers who have looked upon ammonium as well as potassium alum as properly included under the unmodified term "alum," as the following references indicate: [1](The references are from Dr. Patterson)

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[1]The Meaning of the Word Alum.

> "In the alum of commerce, or rather in the form offered to us as a medicine, there is a proportion of potash or ammonia." Parr, London Medical Dictionary (1809).

> "Of alum whether containing potassa or ammonia." Booth Encyclopedia of Chemistry (1850), page 127.

> "Amonnia alum answers quite as well as potash alum, and hence both of these salts are sold under the common name of alum." Bloxam, Chemistry, 4th ed. (1883), page 339.

> "Alum. 1. A double sulphate of aluminium and potassium or ammonium. 2. Generically, any compound isomorphous with ordinary alum and having the general formula." Duane, Dictionary of Medicine, 3rd ed. (1900), page 21.

Dr. Patterson is right when he states "Lexicographers should recognize, therefore, the claim of potash alum to a specific sense of the word 'alum';" he is wrong when he continues "but they should couple with it the meaning of ammonia alum in the same sense, as justified both by the citations from the literature and by the interchangeable use of the two salts in pharmacy and in the arts under the unqualified term 'alum.' "

In spite of the few writers to the contrary, potassium alum has been the "alum" of chemistry and of pharmacy for the longest period of time and has been so accepted by the greatest number of authorities. The policy of including ammonium alum as well as potassium alum under the unqualified term "alum" is not in accord with chemical usage nor is it to be recommended in the interest of clarity and distinction. Lexicographers should by all means define alum, unqualified, in its primary sense, as potassium alum $K_2Al_2(SO_4)_4 .24H_2O$. This is in accord with customary use, with the principal authorities, with the general chemical understanding and with analogous chemical uses as indicated below, wherein a certain word stands for a specific substance as well as for a class of analogous chemical substances—but not for two specific substances in the same class when used without qualification.

ALUM IN ITS SECONDARY SENSE

The alums form an interesting group chemically and crystallographically (they were among the salts which led to the establishment of the principle of isomorphism by Gay Lussac and Mitscherlich), composed of different metallic elements capable in the first instance of replacing the potassium in common alum, and in the second instance, of replacing aluminium. All are isomorphous and crystallize in the cubic system in octahedra.

Among those in which potassium is replaced by other metals, the aluminium remaining fixed, are:

Potassium Alum $K_2Al_2(SO_4)_4.24H_2O$
Ammonium Alum $(NH_4)_2Al_2(SO_4)_4.24H_2 0$
Sodium Alum $Na_2Al_2(SO_4)_4.24H_2 0$
Rubidium Alum $Rb_2Al_2(SO_4)_4.24H_2O$
Caesium Alum $Cs_2Al_2(SO_4)_4.24H_2O$
Silver Alum $Ag_2Al_2(SO_4)_4.24H_2O$

Among those in the second group in which aluminium is replaced by other metals, or in which both potassium and aluminium are replaced, are the following:

Potassium Iron Alum $K_2Fe_2(SO_4)_4.24H_2O$
Potassium Chromium Alum $K_2Cr_2(SO_4)_4.24H_2O$
Ammonium Chromium Alum $(NH_4)_2Cr_2(SO_4)_4.24H_2O$
Ammonium Iron Alum $(NH_4)_2Fe_2(SO_4)_4.24H_2O$

The following general formula may be used to represent the class of alums:

$$M'_2\ M'''_2\ (SO_4)_4\ .24H_2O$$

in which M' represents a monovalent metal and M''' a trivalent metal. Thus an alum may be defined as a crystalline compound of the cubic system, the double sulphate of two atoms of a monovalent metal and two atoms of a trivalent metal containing twenty-four molecules of water of crystallization. The general formula may also be written

$$M' M''' (SO_4)_2 .12H_2O$$

and on this basis the definition would be, an alum is a crystalline compound of the cubic system, the double sulphate of a monovalent and a trivalent metal, containing twelve molecules of water of crystallization.

The formulae with twenty-four molecules of water of crystallization are in general use as they bring out clearly the relationship between the ordinary sulphates of the metals and the alums. The formula for alum (common alum) may be written as follows:

$$K_2SO_4 .Al_2(SO_4)_3.24H_2O.$$

but the half-formula with twelve molecules of water could not be written in this way.

The properties of some of the well-known alums are of interest by way of comparison. Melting points and solubilities of the alkali metals (and ammonium) are given in the following table (Mellor):

	Sodium	Potassium	Ammonium	Rubidium	Caesium
Melting point °C....	66°	92.5°	94.5°	105°	120°
Solubility 16°, 100 grams water..	51	15	12	2.2	0.6

From what has gone before it is clear that the criteria of an alum are:

1. A crystalline salt of the cubic system.
2. A double sulphate of a monovalent and a trivalent metal.
3. Containing in the double formula 24-molecules of water.

There is nothing arbitrary about these criteria. They are reasonable. It has been shown that they are in conformity with the general understanding of the word (and the substance) by those best qualified to know its correct meaning and to use it in its proper sense. There is no valid reason for broadening or extending the definition so as to include other substances which may be related to alum, or the alums, but which are more correctly designated by other words.

ANALOGOUS USE OF CHEMICAL WORDS

There are numerous analogies in chemical terminology between the use of "alum" in its restricted and its general sense and other words similarly used. Such, for example, are the following:

The word "salt" unqualified signifies common salt or sodium chloride, but in its general sense denotes a large group of chemical substances composed of a metallic or other base and an acid radical.

The word "alcohol" unqualified means common alcohol, grain alcohol, ethyl alcohol, whereas in its general sense it signifies a group of organic substances containing the hydroxyl radical.

"Sugar" without qualification means cane sugar or sucrose but in its general sense it covers a considerable group of organic substances of sweetish taste belonging to the carbohydrates, of which cane sugar is but one member.

"Ether" means common ether or ethyl ether but in a general sense the ethers are a large organic group, the oxides of organic radicals.

"Aldehyde" means ethyl aldehyde but in a general sense refers to the group of aldehydes, organic substances characterized by the CHO group.

Similarly, Mercaptan and The Mercaptans; Aniline and The Anilines; Mustard Oil and The Mustard Oils.

In each instance, if the specific word is used alone, a specific substance is meant, if the generic term is used it must be qualified in order to signify a special substance. Thus alcohol unqualified means ethyl alcohol, but many other alcohols are known, such as methyl alcohol, normal propyl alcohol, isopropyl alcohol, normal butyl alcohol, isobutyl alcohol, etc. etc.

Other examples of a similar kind might be given but the above indicate the general trend of chemical usage. Other sorts of word usage in chemistry would only tend to create confusion amongst chemical terms.

A series of alum-like substances is known in which the sulphur of the sulphate radicle of the alum series is partly or wholly replaced by selenium, in other words, the salts of this series which are isomorphous with the alums are mixed double sulphate-selenates of a monovalent and a trivalent metal. They contain the same water of crystallization and are isomorphous with the true alums. They are properly designated as selenate alums.

Other double sulphates of a trivalent and a divalent metal exist, which are not isomorphous with the alums, and these are sometimes called pseudo alums. They also contain twenty-four molecules of water, as indicated by the following formulae:

$$Al_2(SO_4)_3.MnSO_4.24H_2O$$
$$Al_2(SO_4)_3.FeSO_4.24H_2O$$

The term pseudo alums might be considered satisfactory for this group but a more specific designation, such as the crystalline double sulphate of such and such metals, would be more definite and appropriate.

THE TWO MEANINGS OF THE WORD "ALUM"

Thus it is seen that there are two meanings for the word "Alum" as shown by the historical development of its sense from the Latin *alumen* and current good usage by the majority of authorities, with special emphasis on chemical authorities. The word "alum" when used without qualification means crystalline potassium aluminium sulphate ($K_2Al_2(SO_4)_4.24H_2O$). If qualified in any way as by an article, *an* alum, *the* alums, *ammonium* alum, etc. etc., it means one or the whole of a group of analogous, isomorphous compounds having similar chemical constitution. It is unfortunate that a little confusion has been introduced in connection with the sense of the word "alum" when it has been used, although in a minority of instances, and principally in pharmacy, to denote without distinction potassium alum or ammonium alum. It has not, however, been so used, or used at all generally by chemists, who must be considered the final authorities on chemical names.

The use of the word "alum" in its two senses, primary and secondary, is in conformity, as has been shown above, with general chemical usage. Such usage may be considered as established and deviations therefrom are uncalled for, undesirable and confusing. It should not be necessary to lay special emphasis upon keeping the scientific vocabulary clear and precise, but one might say in passing that no exigencies of legislation, or ethics of advertising, or controversies relating to foods, or controversies of a legal nature, should be allowed to influence the definition and meaning of scientific words.

SODIUM ALUM

It is characteristic of many sodium salts that they do not crystallize as readily or well as the corresponding potassium salts and this is true of sodium alum, crystalline sodium aluminium sulphate $Na_2Al_2(SO_4)_4 .24H_2O$. So poorly does sodium alum crystallize that for a long time there was doubt as to its identity as a distinct chemical and crystallographic species, but careful investigation has since removed this doubt and proven its analogy to potassium alum. If sodium alum had possessed the property of crystallizing more readily, it is likely that it would have been known quite as early as or earlier than potassium alum. As a matter of fact, it made its appearance much later and never came into common, everyday use after the manner of potassium alum and only recently has it been used to any considerable extent in the arts. Ure's Dictionary, published in 1867, Sixth edition, states that sodium alum "is not an article of commerce nor is it used in the arts," whereas Martin (Industrial Chemistry, Inorganic, II, 1917) states:

> "SODIUM ALUM, $Na_2SO_4.Al_2(SO_4)_3.24H_2O$, is also prepared on a large scale. It is more soluble in water than potassium alum, and is also cheaper. It is, however, more difficult to prepare pure than either potassium or ammonium alum, on account of its great solubility, 100 parts of water dissolving 51 parts sodium alum at 16°C."

The quotation from Martin may indicate merely that the manufacture of sodium alum developed in England during the late war as a matter of necessity.

Up to the present time sodium alum has been looked upon almost as a chemical curiosity. It is not generally found among the stock of chemicals or drugs in laboratories, pharmacies, or chemical supply houses. Chemists make no use of it. Even during the late war, when potash salts were scarce, owing to Germany's control of the principal source, sodium alum failed to come on the market in large quantities or into general use.

SODIUM ALUMINIUM SULPHATE—S. A. S.

Sodium aluminium sulphate is a salt used in baking powder manufacture and is commonly known by that name in the trade or in brief form as S. A. S. (comp. T. N. T. for trinitrotoluene). This substance is correctly named, the name indicating its chemical composition and hence its chemical characteristics and no confusion can result from the use of such a name. Sodium aluminium sulphate is not properly speaking either "alum" or an alum. If it were in crystalline form, with twenty-four molecules of water it could properly be called a member of the alum group or sodium alum, but since it contains no water of crystallization and thus does not possess either the chemical structure or crystalline form characteristic of the alum group, it would be incorrect to call it either alum or an alum. In such a case the only correct usage would be the full chemical name signifying the substance or the abbreviated form, S. A. S. which signifies sodium aluminium sulphate, the substance commonly used in baking powder. To say that the public does not understand a chemical expression of this sort is somewhat beside the point; neither does the public understand the chemical significance of sodium chloride, or of sugar, or of alcohol. In recent years the public has had to be very carefully educated in regard to the difference between alcohol (ethyl alcohol, grain alcohol) and wood alcohol (methyl alcohol). The public cannot be expected to know the significance of chemical words or of technical words generally and must accept the professional man's dictum as to their meaning. Certainly a confusion of technical words and phrases for the purpose of conforming to popular usage or supposed usage is unwarranted. Scientific words derive their meanings from scientific usage and not by the misusage of the general public. Any other principle would result in hopeless confusion, not only of general words but especially of scientific words and phrases.

TRADE JARGON AND SHOP-TALK

The use of special words and phrases, usually of a slang nature, is general in all trades, businesses, shops, plants and offices, usually or frequently to denote by a short word or term what is more correctly named by a longer word or phrase. Many of these expressions are short-lived, others are useful or even necessary and have a permanent existence within the special trade or branch of business in which they originate. Others, few in number, are finally adopted as an integral part of the language and these may enter into the standard dictionaries. Expressions of this sort should, however, be carefully scrutinized by the student and lexicographer before they are so adopted since otherwise only confusion will result with no corresponding advantage.

In the majority of cases when words and phrases of the nature of trade slang and shop talk are used by men in a particular branch of business or manufacture, they well know that they are not using the correct expression but a substitute which may be shorter or, to them, more expressive for the purpose in hand. In the majority of cases or, at any rate, in the first instance, they know the correct name or phrase for the thing or operation indicated, as well as the slang phrase. They prefer to use the latter because of its brevity or piquancy, or for any of the various reasons that govern the use of slang in every-day speech. There is no confusion in their own minds as to the thing or operation indicated when the slang phrase is used and since the word or phrase seldom reaches beyond the boundaries of their own field, no general harm is done. It is only when the attempt is made to extend the slang phrase or trade jargon beyond its legitimate confines that confusion of thought or speech may result among the uninitiated.

ALUMINIUM SULPHATE

The principal uses for alum in manufacture and the practical arts have been chiefly four:

1. As a mordant in dyeing cotton and wool.
2. For sizing paper.
3. For tawing leather.
4. As a coagulating, clarifying and precipitating agent for the purification of water and various liquors in the course of treatment or manufacture.

As a mordant for certain dyes, particularly alizarine, a high degree of purity is necessary with respect to iron, and the necessary purity is easily obtainable in the case of alum on account of its easy crystallization. In the case of paper sizing also a high degree of purity is desirable, although not so necessary as in the case of dyeing. For water clarification and the clarification of various liquors, iron and other common impurities would not as a rule be detrimental. It became possible after many trials to produce an aluminium sulphate of a high degree of purity and practically free from iron and when this was accomplished this salt began to supplant alum in the arts. For the three purposes named above, only the aluminium in alum functioned, the potassium remaining inactive in the reactions involved. Therefore, aluminium sulphate served quite as well as alum, provided it was of equivalent purity. There were also other advantages—cheapness and concentration. Alum contains the equivalent of 10.77 per cent alumina (Al_2O_3), ammonium alum contains 11.27 per cent, commercial aluminium sulphate, 15 to 16 per cent, and pure aluminium sulphate ($Al_2SO_4)_3$, 29.85 per cent. The advantage of aluminium sulphate, therefore, is manifest and this would be particularly true at times when potassium salts were scarce or high in price, since both manufacturing costs and freight would be lower for aluminium sulphate than for alum.

At the present time the principal raw material for the manufacture of aluminium sulphate is Bauxite although some is still manufactured from cryolite and China clay.

THE WORD "ALUM" USED AS TRADE JARGON

During recent years, therefore, aluminium sulphate has come into very general use for the clarification of water and in other clarifying and precipitating operations and in dyeing and in paper sizing in place of alum. It is cheaper than the latter and, weight for weight, is more effective since it contains a larger percentage of aluminium, which is the active agent in either aluminium sulphate or alum, for the purposes mentioned. It must not be understood that aluminium sulphate is a substitute for alum for every purpose but only in those cases where the aluminium is the active chemical agent and the potassium does not go into the reaction. For purposes where the potassium was desired or where the whole properties of alum might be useful, aluminium sulphate could not be used as a substitute therefore. When aluminium sulphate displaced alum in clarifying and precipitating processes, dyeing and paper making, workmen and engineers began to call it by the old name "alum," most of them with full understanding that it was not identical with the alum they had previously used. The word was short and convenient and when used in works which made use of only one or a few chemicals, caused no confusion or misunderstanding. Even in the literature one finds frequent references to aluminium sulphate under the name "alum" generally in papers by engineers rather than by chemists. However, the use of the short word, even trade jargon, never became general and, in fact, it is questionable whether it is now used in the majority of instances. The correct name aluminium sulphate, or the older equivalent, sulphate of alumina, is used by the majority of chemists, engineers, superintendants, purchasing agents and manufacturers to designate the combination of aluminium with the radical of sulphuric acid. The trade-slang word "alum" has never replaced the correct expression in any general sense. It is not broadly or generally recognized as a correct expression in this sense. This is as it should be, since the introduction of equivocal words and expressions into technology can only result in misunderstanding and bad practice. Because some workmen and engineers choose to use the short word "alum" for the sake of convenience in place of the longer correct expression, "aluminium sulphate," it does not follow that the latter should be abandoned for the former in water works practice or any other clarification operation or chemical reaction. If any one chooses to use the incorrect word within his own works as a matter of convenience or for any reason whatever, that is his own affair, but it would be a very different matter if such usage were recognized by chemical experts or lexicographers as a proper usage or as a displacement of the correct expression. Such substitution would be wholly unwarranted and *de facto* does not exist.

DICTIONARIES OF TRADE SLANG

If we were to accept the principle that all examples of trade argot and business slang, which come at all into general use, should be incorporated into our general dictionaries as the equivalents of correct words or of recognized words then in use in another and distinct sense, we would begin a cluttering-up process which would never end. Business, trade and manufacture are filled with words used in an incorrect sense, with misapplied words and with invented words applied to particular things or processes. These are all well understood in the circle in which they are used but could not be brought into the general language without confusion.

Who knows the meaning of "floates," "slick," "pickle," "dope," "glory hole," "B. S.," "slunk," "soup," etc.

Indeed, such words as these are as a rule not specific but are applied to numerous different products or processes in different trades or business. For example, the word "pickle" may mean almost any sort of a solution in which almost any sort of a thing is soaked, from salt brine for hams to sulphuric acid for steel. "Dope" may mean any sort of a composition applied in liquid form to an object or surface. It may also mean any narcotic drug in common use for purposes of intoxication. But again, "dope" means, to the sporting fraternity, especially but not exclusively, any accurate inside or special secret information.

The meaning changes with each different shop, trade, or group.

Similarly, can it be imagined that a classically educated person would recognize such words as "goat," "chicken," "flapper," "mug," "map," "smoke-wagon," "gat," "bat," "dog," "Jack," "bone," "berry," "lid," "sheik," "hot-air," "nut," "skate," "mucker," "lamp," "stew," "sponge," "queen," "once-over," in their slang sense? Nearly all of these have an accepted and definite meaning and are simply misapplied for the purposes of slang phrasing.

It may be argued that alum when misapplied in the sense of aluminium sulphate or other aluminium salt having astringent properties is not in the class with the foregoing trade-slang and general slang words. This fact can be readily granted. Certainly it runs closer to the correct sense of alum than do some of these words to their true meanings, but in this very fact lies the danger of misuse and confusion. When the word "alum" is applied to a vegetable root having astringent properties, there is little danger of misunderstanding, but when applied to a mineral substance of somewhat similiar properties and usage to alum, then there is every opportunity for making a blunder. In the former case, nothing more serious is represented than colloquial misuse or a metaphorical figure of speech, whereas in the latter case definite scientific misapplication of a word is involved.

The proper place for shop slang and trade jargon is in the shops and trades, and if it becomes necessary to make lexicons of such words and phrases, then let them be placed in dictionaries of trade slang. Indeed, such dictionaries are already known and in use and there is every propriety in having them available for their special purpose and for the special student. Occasionally a word from such a list might be carried over, indeed, should be carried over into general dictionaries but only in cases where the word is actually needed for the sake of clarity and when its introduction will not result in the confusion of other terms.

THE LOGICAL CONCLUSION

If we are to conclude that because aluminium sulphate has replaced alum in the practical arts and manufactures to a certain extent, that the word "alum" means aluminium sulphate, we have not reached the end of the possibilities. If we do not draw the line where it should be drawn, as indicated in what has gone before, there is no place where it can be reasonably and properly drawn.

There are numerous other soluble salts of aluminium which are capable of replacing aluminium sulphate. That they do not at present is because of their higher cost or because they are not manufactured in quantity. It is conceivable, however, that any of the soluble salts of aluminium might be used in place of aluminium sulphate in mordanting, paper-making and clarifying and that workmen and engineers would call these substitutes by the name "alum." Therefore, under this term we might include, if we accept the general principle, such salts as aluminium chloride, aluminium acetate, aluminium borate and aluminium nitrate.

Pseudo-alums would also be called "alum" without qualification.

But there are other substitutes for aluminium sulphate as a clarifying agent and precipitant, particularly the sulphates of iron. If copperas, for example, were substituted for aluminium sulphate in a precipitating operation, the workmen might call it "alum" for short, and it too would then be included under the term "alum."

A still further extension might be considered to include all astringent substances of whatsoever nature, as has been done in the past by the ignorant (hence the term "alum-root") and there would be no end to the kind of chemical substances included under the word "alum."

But all this is illogical and contrary to the present trend of chemical terminology and lexicography as has been shown before. Such a course tends only to confusion and works no good result whatever. Nothing can be said in favor of it.

PERMANENCE OF SCIENTIFIC WORDS

It may appear to some readers that undue emphasis has been laid upon the fixity or permanence of scientific names and terminology, but the principle of permanency or fixity must not be thought to interfere with the evolution of language or of scientific terminology. On the contrary, that evolution will take its course and proceed in spite of all rules or restrictions. It is the natural tendency of lexicographers to assist it in right directions and to attempt to head it off in wrong ones. Clarity of expression and definiteness of meaning are the guides. In the case under discussion, if a new word were to be substituted, in the course of time, for alum, one of three courses might be followed:

1. The new word might be substituted for alum in the restricted sense.
2. Or, the new word might be substituted for the generic term meaning the group of alums.
3. Or, the new word might be substituted for both the specific and the generic terms.

Of these three possibilities, one of the first two would be preferable, thereby distinguishing between alum and the group of alums of similar chemical and crystallographic structure—but there is something to be said against such a course. There is a decided propriety in naming the specific substance "alum" and the group "the alums," thereby showing the chemical relationship just as in the case of other chemical substances tabulated before. But to extend the name to include other substances of different constitution and crystallographic structure can have no other effect than confusion of language and meaning.

SHOULD THE MEANING OF THE WORD "ALUM" BE EXTENDED TO INCLUDE SUBSTANCES OTHER THAN ALUM OR THE ALUMS

Dr. Patterson says that a third sense of the word "alum" should be recognized and given standing in dictionaries, this third sense being "aluminium sulphate in any form." This he argues "is not a technical chemical sense and yet it is frequently used by chemists and appropriately so, because it is based on the common chemical action shown by all forms of aluminium sulphate, and not on crystal form." [1](loc. cit. pp. 9-10.)

In order to place Dr. Patterson's argument clearly in evidence, it becomes necessary to quote at this point *in extenso* from his authorities and conclusions and to comment on them *seriatim.*

He bases his conclusion on historical evidence that the word "alum" was used to include aluminium sulphate in various forms of combination in former times and that it is now used, especially among engineers and technologists, in this sense. He also thinks that the general public should be considered in framing the definition and that any substance containing aluminium sulphate should be called alum for their benefit.

It is conceded that in Roman times, and until chemical analysis distinguished between substance and substance, that *alumen* covered a variety of substances. The confusion that existed then because there was no escape from it is just as excusable as the same condition would be inexcusable now. Dr. Patterson states:

> "That common alum was regarded, as late as the end of the 18th century, as essentially aluminium sulfate is shown by the following citation:
>
> "'*Alum* is a neutral salt, consisting of sulphuric acid combined with aluminous earth or fine clay, and it merits of consequence, the name of *aluminous sulphate.* Hellot, Geoffroy, Pott, and more especially M. Baumé have all formed *genuine alum* by mixing *clay* with the sulphuric acid. *Aluminous* sulphate, or *alum,* at first affects the organs with a sweetish taste, and is afterward felt to be strongly astringent . . . Mineralogists, particularly Wallerius, have taken notice of several species of *native alum.*'
>
> Fourcroy, Elements of Chemistry and Natural History, trans. Heron, London (1796), page 95.

"The next citation makes it clear that, even after it was recognized that 'the common alum of shops' contains an alkali, all forms of aluminium sulfate were spoken of as 'alum.'

> 'Hence, it appears that there are several varieties of salts, composed wholly, or for the most part, of sulphuric acid and alumine, clearly distinguishable from each other, though generally confounded together under the common and vague name of alum.
>
> 1. The first is sulphat of alumine, being a saturated combination of alumine and sulphuric acid.

2. The second is acid sulphat of alumine, and differs from the preceding only in containing an excess of acid.

3. The third is acid sulphat of alumine with potash, crystallizing in octahedrons.

4. The fourth is acidulous sulphat of alumine with potash, crystallizing in cubes.

5. The fifth is sulphat of alumine with potash, or alum neutralized by its own earth, pulverulent, insipid, insoluble in water.

6. The sixth is acid sulphat of alumine with ammonia.

7. And the seventh is acid sulphat of alumine with potash and ammonia, or the common alum of the shops.'

"Aikin's Dictionary of Chemistry and Mineralogy (1807), Vol. 1, page 42."

In the quotation from Fourcroy, "*genuine alum*" is spoken of as made by "mixing clay with the sulphuric acid." By "*genuine alum*" Fourcroy obviously means potassium alum. He goes on to speak of aluminous sulphate or alum, thereby indicating one variety of alum, more properly and more definitely designated "aluminous sulphate."

The quotation from "Aikin's Dictionary" is somewhat unfortunate for the argument since it states "that there are several varieties of salts, composed wholly, or for the most part, of sulphuric acid and alumine, clearly distinguishable from each other, though generally confounded together under the common and vague name of alum." Aikin goes on to list these substances which are "clearly distinguishable from each other" but which are "generally confounded together under the common and vague name of alum." He knew that the term "alum" could not properly be stretched to include a considerable list of aluminium salts. He felt that such a method was not correct either in common sense or chemical terminology. The quotations prove nothing but the improper use of the word "alum."

Coming down to modern writers, Dr. Patterson cites numerous quotations to indicate that alum may properly be used "in the sense of aluminium sulfate, either alone or combined with other salts—" "in the sense of aluminium sulfate, uncombined with other substances," and "in the sense of aluminium sulfate, combined with other salts." Practically all of the quotations come from technologists or engineers, not from chemists. It is somewhat astonishing that if the word "alum" is properly to be considered as meaning aluminium sulphate in any form whatever, that numerous citations from chemical authorities are not available to this effect and that recourse must be had to that class of people who are known to miscall chemical substances and to make use freely of trade jargon and shop talk for their every-day work.

In considering "Alum in the sense of aluminium sulfate, either alone or combined with other salts," Dr. Patterson quotes from one author only, as follows:

> "It was not until the middle of the 19th century that commercial aluminum sulphate made its appearance on the market in considerable quantities and its advantages in certain industries over the crystallized alums were so evident that it gradually supplanted them until at the present time by far the greater part of the alum trade centers around aluminum sulphate.
>
> 'While the term 'alum' as applied in commerce is generally understood to cover quite a few different products, the alums can be classified into two groups, the crystal alums and the aluminum sulphate. The most im-

> portant crystal alums consist of the double sulphate of potassium or ammonium on the one hand and aluminum on the other.
>
> 'The principal uses of alum are for water purification, paper manufacturing and for the production of lakes.
>
> 'The function of alum in the purification of drinkable water is based on the fact that aluminum sulphate reacts with alkaline substances to produce hydrate of aluminum."
>
> Article by H. D. Schanche on "Alum and Its Uses," Dupont Magazine, April, 1918, page 10. (Thruout this article, alum is used to mean either sulfate of aluminium or its combination with an alkali sulfate.)"

Even Dr. Schanche, writing for laymen in a trade journal of comparatively limited circulation, distinguishes between "the crystal alums" and "the Aluminum sulphate." He recognizes the difference clearly but after the manner of users of trade slang and as a matter of convenience he later calls both crystal alums and aluminium sulphate, alum.

It is a general principle in trade that when a cheaper article is introduced as a substitute for a more expensive one, that an attempt is made to give the cheaper article the name of the more expensive. Thus it is with aluminium sulphate. It was a perfectly natural and commercial thing to attempt in a trade campaign to "put over" aluminium sulphate as "alum." The use of the word "alum" made it easier for salesmen to sell aluminium sulphate in place of the alum formerly used. But there was no real misunderstanding on their part or on the part of the users with reference to the product. Each knew that the product in question was aluminium sulphate.

Considering "'Alum' in the sense of aluminium sulfate, uncombined with other substances," Dr. Patterson quotes as follows:

"(1) In the Chemical Engineering Catalog for 1923 the following phrases denote aluminium sulfate—extra concentrated alum, filter alum, paper-makers' alum, pearl alum, pickle alum, sizing alum.

(2) 'Concentrated alum' and 'patent alum' have been in use for some time as names for aluminium sulfate. See the dictionaries.

(3) In water purification—

'The plant at Columbus is different from all others because the alum it produces is not crystallized into alum cake. It is made from sulphuric acid and bauxite.''

Engineering News, Jan. 4, 1917.

'The layer of alum or aluminum sulphate formed in the plant as it is now being operated at Trenton, is some three inches thick.'

Engineering News, Jan. 4, 1917.

'Change from alum to iron at Clarksburg water filters. The substitution of ferrous sulphate for aluminum sulphate of the Clarksburg, West Virginia, waterworks has greatly reduced the war-time cost of coagulant.'

Engineering News, Nov. 16, 1916.

'On July 5, 1915, a plant for the manufacture of aluminum sulphate at the West Parrish Filters, Springfield, Mass., was put into operation . . . The normal capacity is 1,000 lbs. of alum every day.

Water company makes its own alum and chlorine. Plants for making filter alum from bauxite and chlorine gas from brine are being built . . . The filter alum or sulphate of alumina plant will have a capacity of five tons a day.'

Engineering News, Sept. 7, 1916.

(4) In paper sizing:

'When a drop of rosin is brought into a solution of aluminum sulphate or a drop of aluminum sulphate is added to a solution of rosin size, a small vesicle forms which is surrounded by a film of precipitate . . . From this it may be deducted that the fibers, were not washed free from the reagent, alum.'

Paper, Jan. 17, 1923, page 11.

'The result produced with sulphate of aluminum therefore will depend entirely upon the action of the materials, equilibrium being established in accordance with the relative amount and acidity of the alum used.' Paper, (Oct. 4, 1916, page 39.)

'(2) An aluminium sulphate of the following composition—$Al_2(SO_4)_3$ 80%, free H_2SO_4 none, moisture 15, impurities 5. It is assumed that on adding the alum to the water only one-third of the compounded rosin is as free rosin.'

Paper Trade Journal, Oct. 19, 1922,

Page 51.

(5) In fireproofing:

" 'The effect of certain fireproofing solutions on cotton fabric,' by R. L. Sibley . . . A.—The fabric was boiled in saturated solution of $Al_2(SO_4)_3.18\ H_2O$ for 15 min., dried in an oven at 80°C., boiled for 15 min. in a saturated Na_2CO_3 solution, allowed to dry, and tested. . . . No breaking tests could be obtained on the fabric treated with solution A, inasmuch as the fabric had been so seriously affected by the alum as to be easily torn apart in the fingers."

Journal of Industrial and Engineering Chemistry *133* 676-7 (1921).

(6) In agriculture:

" 'The effect of alum on silicate colloids,' C. S. Scofield. J. Wash. Acad. Sci., 2, 438-9 (1921). Many irrigated lands contain considerable sol. silicates combined chiefly with Na. When the salts of stronger acids are washed out these colloidal sillicates check the movement of water. $Al_2(SO_4)_3$ is effective in improving such soil conditions and can be used freely on alk. land without injury to succeeding crops. The rate of application required has not been det., but marked improvement has been noted from the application of 1 ton per acre. The use of alum opens an important field of investigation for irrigated land alk. in reaction."

Chemical Abstracts *16*, 782 (1922).

(7) In analysis:

" 'The determination of free acid in aluminum sulfate solutions,' H. Zschokke and L. Hauselmann. *Chem. Ztg. 46*, 302 (1922). By adding $BaCl_2$,$K_4Fe(CN)_6$ and gelatin to an aq. alum soln., the Al is pptd. and, after filtration the free acid can be detd. by direct titration with NaOH. Into a 100 cc. calibrated flask, introduce 10 cc. of the alum solution." . . .

Chemical Abstracts *16*, 2093 (1922).

(8) In mining:

Analyses of native alum deposits . . . are given.

Chemical Abstracts *15,* 1588 (1921).

(9) As a mineral name:

'Feather alum. The normal salt $Al_2(SO_4)_3$ 18 aq. occurs native as feather alum.'

Watts' Dictionary of Chemistry (1894), Vol. IV, page 568. (The name "feather alum" for native aluminium sulphate is given in the general dictionaries also.)"

In every one of the above quotations there is internal evidence to indicate that the writers clearly understand that they are speaking of aluminium sulphate and not alum—and that when they use the term "alum" they do not mean what they say, but that they are using a short, convenient word in place of the longer correct word. The word "alum" used with a modifying word, for example, "extra concentrated alum, filter alum, paper-makers' alum," etc. is very different from the same word used to include these various substances without a modifying word. To the former usage no great exception can be taken if tradespeople want to make use of the word in that way, but to the latter use no chemist can properly agree. It is to be noted that in the above group there is only one quotation which comes clearly from a chemist, writing as a chemist, namely, that from chemical Abstracts *16,* 2093 (1922).

The quotations relating to mining and mineralogy referring to "native alum" and "feather alum" are not to the point.

In considering "'Alum' in the sense of aluminium sulfate, combined with other salts," Dr. Patterson argues as follows:

"Here the second and third senses of 'alum' overlap, because the double salts of aluminium sulfate with alkali and ammonium sulfates have

> the same crystal form as potash alum—by either sense they would be called alums, so they will not be discussed further here.
>
> "But there are certain other aluminium sulfate combinations which are not alum by sense 2—nevertheless they are called alum, and this can only be by sense 3. Examples are halotrichite, a ferrous aluminium sulfate, which is called 'plum alum' and 'feather alum,' and apjohnite, a manganous aluminium sulfate, which is called 'manganese alum.' These names of minerals, and also that mentioned in II (9), above, are not technical mineralogical terms. Their date of origin would be hard to ascertain. They are examples of the general tendency, which has probably existed all along, to call any form of aluminium sulfate 'alum'."

The conclusion that these "are examples of the general tendency, which has probably existed all along, to call any form of aluminium sulfate 'alum' " does not seem warranted. As explained before, the use of the word "alum" with a modifying word by mineralogists, technologists, engineers, irrigation men, water-works superintendents and the laity, cannot be criticized if they choose to make use of these words and if they know what they are talking about, but if the word "alum" is used to include all these substances *without* modifying words, the case is very different and such practice cannot be permitted.

MODERN DEFINITIONS OF ALUM

To set against these mixed uses of the word "alum" quoted by Dr. Patterson, chiefly from trade journals and the pens of engineers, metallurgists, water-works and irrigation experts and salesmen, there are a host of competent chemical authorities. Practically every text-book on inorganic chemistry and every dictionary of chemistry has the word correctly defined and used. Indeed, Dr. Patterson concedes that all the modern chemical authorities consider the word "alum," unrestricted, to mean common alum or potassium alum, and that alum in its secondary meaning designates the group of crystalline double sulphates of aluminium and a monovalent metal.

Witness the following:

"Aluminium sulphate can combine with the alkaline sulphates and affords double salts, termed *alums, e.g.,* potassium alum:

$$Al_2(SO_4)_3.K_2SO_4 + 24H_2O \text{ or } KAl(SO_4)_2 + 12H_2O.$$

"Their constitution is expressed by the following formula:

$$SO_4 = Al''' - SO_4 - K + 12H_2O.$$

"In this compound the potassium may be replaced by sodium, ammonium, rubidium, caesium, and also by thallium, hydroxylamine, and some organic bases. Iron, chromium and also vanadium, titanium and manganese afford like derivatives:

$$Fe_2(SO_4)_3.K_2SO_4 + 24H_2O$$

Potassium iron alum.

$$Cr_2(SO_4)_3.(NH_4)_2(SO)_4 + 24H_2O.$$

Ammonium chromium alum.

"All these alums crystallize in regular octahedra or cubes, and can form isomorphous mixtures.

"The most important of them is *potassium aluminium sulphate* or *ordinary alum,* $KAl(SO_4)_2 + 12H_2O$."

Richter-Smith. Inorganic Chemistry, page 352.

"ALUMS.—When a hot solution of aluminium sulphate is mixed with potassium sulphate, and the solution is cooled, octahedral crystals of a double sulphate of aluminium and potassium separate. The salt has the

empirical formula, $K_2SO_4.Al_2(SO_4)_3.24H_2O$, or else $KAl(SO_4)_2.12H_2O$. This salt is a typical member of a large number of isomorphous compounds which are called 'alums.' Their general formula is:
$R_2SO_4.R_2''' \ (SO_4)_3.24H_2O$; or, $R'R''' \ (SO_4)_2.12H_2O$ where R′ represents an atom of a univalent metal or radicle — potassium, sodium, ammonium, rubidium, caesium, silver, thallium."

Mellor. Modern Inorganic Chemistry, page 450.

"ALUMS are double sulphates, the most important of which is the so-called potash alum or ordinary alum of commerce. This aluminium potassium sulphate, ($Al_2(SO_4)_3$, K_2SO_4, $24H_2O$), is a colourless crystalline efflorescent salt, made on a large scale by mixing the two sulphates and allowing the compound to crystallize out of solution. . . . .

"Ammonia alum or aluminium ammonium sulphate contains ammonium in place of the potassium of ordinary alum."

Kingzett. Chemical encyclopaedia, pages 24-25.

ALUMS.—A class of compounds having the general formula:

$$M'_2SO_4.M'''_2(SO_4)_3.24H_2O, \text{ or}$$
$$M'M'''(SO_4)_2.12H_2O$$

M′ is a univalent metal such as potassium, sodium, caesium, silver, etc. Ammonium, NH_4, may also take the place of M′, forming the ammonium alums. M′ is a tervalent metal, such as aluminium, iron, chromium, etc. Selenates, as well as sulphates, form alums (selenium alums). All the alums are isomorphous, crystallizing in the octahedral system. The following are typical alums,—Common alum, alum, or potash alum, $K_2SO_4,Al_2(SO_4)_3.24H_2O$; iron alum, $K_2SO_4.Fe_2(SO_4)_3.$-$24H_2O$, chrome alum, $K_2SO_4.Cr_2(SO_4)_3.24H_2O$, ammonium alum, $(NH_4)_2SO_4.Al_2(SO_4)_3.24H_2O$."

The "Chemical Age" Chemical Dictionary, pages 15-16.

"ALUM was the name given originally to a double salt of aluminium and potassium sulphate, $AlK(SO_4)_2.12H_2O$, which crystallizes in fine octahedra belonging to the regular system, on mixing the solutions of the single salts. . . . .

"Alum was formerly the most important salt of aluminium. Although the potassium sulphate contained in it had either no effect or had a disturbing effect in its applications, alum was nevertheless employed, because none of the simple salts of aluminium crystallize well, and thus cannot be easily freed from impurities. Since the method was discovered of preparing pure aluminium hydroxide (by way of sodium aluminate), and so of preparing pure aluminium sulphate from this, alum has lost its importance, and is now being more and more replaced by the simple sulphate. . . . .

"Potassium aluminium sulphate is the type of a large series of double salts, which have a similar composition, and crystallize in the same forms of the regular system. The place of potassium can be taken by *rubidium, caesium, ammonium,* and a large number of *organic derivatives of ammonium,* as well as by the heavy metal *thallium,* but not by sodium or lithium. The place of aluminium can be taken by other metals, which form *trivalent* ions, such as *iron, chromium, manganese, indium,* etc. Finally, in place of the sulphanion we can have selenanion, SeO_4. Hence, we have a great diversity here—for all these double salts the name *alum* has been adopted, the name of the metals present being prefixed. These alums are isomorphous with one another, and the supersaturated solution of one of them is made to crystallize by a nucleus of any other."

Ostwald-Findlay. The Principles of Inorganic Chemistry, pages 564-565.

"ALUM, $K_2SO_4.Al_2(SO_4)_3.24H_2O$.—The most important raw material for the manufacture of alum is

BAUXITE—of lesser importance is ALUNITE (alumstone) and Kaolin. Some alum and aluminium sulphate is also produced from KRYOLITE. . . . .

"AMMONIUM ALUM, $(NH_4)_2SO_4.Al_2(SO_4)_3.24H_2O$, is prepared in a manner precisely similar to potassium alum, merely by adding ammonium sulphate to a solution of aluminium sulphate. . . .

"Both *alum* and *aluminium sulphate* are used in tanning leather (see Martin's 'Industrial Chemistry—Organic'). Another use of aluminium sulphate is the clearage of sewage water."

Martin. Industrial Chemistry—Inorganic, Vol. II, pages 55, 56 and 57.

The above definitions and descriptions are typical of the current chemical literature. They have been selected almost at random. They represent the present day conception of "alum" and "the alums." Especially do they show the significance which chemists attach to these words, and chemists are the final authorities for chemical words and vocabulary.

In The Condensed Chemical Dictionary (New York, 1919) are the following definitions:

> "ALUM. See aluminium-potassium sulfate, etc. The term alum strictly refers to double sulfates of aluminum and another metal, but is commonly incorrectly used by paper-makers, tanners, etc. to refer to various grades of aluminum sulfate.
>
> ALUM, AMMONIA. See Aluminum-ammonium sulfate.
>
> ALUM, BURNT. See Aluminum-potassium sulfate, Calcined.
>
> ALUM, CHROME. See Aluminum-chromium sulfate.

ALUM, EXTRA CONCENTRATED. Alum containing 22 per cent of aluminum.

ALUM, PEARL. Specially prepared aluminum sulfate for the paper making industry.

ALUM, PICKLE. Aluminum sulfate prepared to meet specifications of packers and preservers.

ALUM, POROUS. See Sodium-aluminum sulfate.

ALUM, ROMAN. Aluminum salts containing insoluble iron salts made at Tolfar, Italy.

ALUM, ROOT. See Geranium.

ALUM, SODIUM. See Aluminum-sodium-sulfate.

ALUMEN, U. S. P., B. P. See Aluminum-potassium sulfate.

ALUMEN PURIFICATUM, B. P. See Aluminum-potassium sulfate.

These definitions are in the main correct and adequate if we take into consideration the fact that no special attention was drawn to the word and no effort made to bring out special distinctions. "Extra Concentrated Alum" is defined as "alum containing 22 per cent of aluminum." Obviously, aluminium sulphate is intended in this instance, and equally obviously "Extra Concentrated Alum" is a trade expression. No one would suppose it to be a chemical name. Likewise, the expressions "Pearl Alum," "Pickle Alum" "Porous Alum," etc. etc. are trade terms belonging to trade jargon.

In order to indicate clearly the manner in which "alum" is used by engineers and water purification experts in its true sense and as trade jargon in the sense of aluminium sulphate, the following quotations are pertinent:

"With such waters it is usual to add a very small amount of some chemical having the power of coagulating organic matter. Such a substance is alum, $Al_2K_2(SO_4)_4.24H_2O$. This is a double salt of aluminium and potassium, and is known otherwise as potash alum."

Booth. Water Softening and Treatment (1906), page 29.

"It is possible to remove from one-half to two-thirds of the organic matter of sewage by precipitation with a proper amount of an iron or aluminum salt."

Fuller. Sewage Disposal (1912), page 540.

"ALUMINUM SULPHATE. Aluminum sulphate $(Al_2(SO_4)_3\ 18H_2O$, commonly called 'filter alum' in its purest commercial form consists of small lumps (½ to 2½ inches in size), hard, having a greasy feel and an opaque, greenish-white color."

Stein. Water Purification Plants and Their Operation (1916), page 144.

"The addition of chemicals to the sewage to increase the degree of clarification was manifestly worth trying. Lime was used as a precipitant in most cases, sometimes alone, but more often in combination with chloride of lime, chloride of magnesium, *sulphate of alumina,* phosphate of alumina, green copperas, black-ash waste, charcoal, herring brine, or some other one of many substances."

Metcalf and Eddy. American Sewerage Practice, Vol. III (1916), page 5.

"SULPHATE OF ALUMINA.—This is known in the trade as basic sulphate of alumina and is usually spoken of as 'alum' by en-

> gineers. Its value depends upon the amount of 'available' or soluble sulphate in it. This ranges from about 16 to 18.5 per cent."
>
> Metcalf and Eddy. American Sewerage Practice, Vol. III (1916), page 454.

It is clear from these quotations from water-works and sewerage practice that sanitary engineers in the first place used alum for water and sewage treatment, later changing to aluminium sulphate, which they in common parlance designated "filter alum," a name presumably proposed by the manufacturers of the article to link it in conjunction with the alum formerly used. However, it is also clear that the engineers knew what they were using in this substitute salt and used the word "alum" as a shorthand designation in place of aluminium sulphate and sufficiently accurate for purposes of trade slang. Whenever occasion arose to call the substance by its correct name, they did so—for example, in the quotation from Stein given above.

SUMMARY

Words come and go in the language, generally without much aid or assistance from lexicographers and, indeed, frequently in spite of their best efforts. They fill a place at a given time for a certain purpose, oftentimes in conformity with the general spirit of the age—then they become obsolete and are forgotten like old tunes. There are no set rules for the adoption of words into the language. Their survival depends on circumstance, environment, cultivation, use and disuse, the exigencies of speech and literature—and more fundamentally still on the requirements of the culture of a people.

The case for scientific words is somewhat different. They undergo few changes. They are more directly under the control of the scientific lexicographer who makes, unmakes and defines them. The demands upon scientific words are more rigorous than upon words of everyday service and literary use. They do not follow even the slow evolutionary movement of ordinary words and this is right and proper. The word "alum" has had a more direct history and line of descent than most words. Its lineage from Roman times is well-known. The Latin *alumen* and *alumen purificatum* are still used by medical men and pharmacists.

We have seen that the word "alum" has been used during the greater part of its history to denote crystalline potassium alum—that it has also been used during a part of this time to mean ammonium alum, which, in the first instance, was a substitute for potassium alum—that the pharmacists still continue the use of alum in the sense of either potassium or ammonium alum—that in a secondary sense alum means any one of the group of alums chemically and crystallographically analogous to potassium alum—and that this usage of the word to indicate in the first instance a definite chemical species and, in the second instance, to denote a genus of similar chemical substances is in accord with chemical custom and use—that in recent years some salesmen, engineers, waterworks experts and laymen have used the word "alum" in the sense of aluminium sulphate and that such a use is merely an example of trade jargon or shop talk and that there is nothing in such usage to warrant extension of the word to mean aluminium sulphate in any form.

Aluminium sulphate is best designated as aluminium sulphate and sodium aluminium sulphate as sodium aluminium sulphate—and these words should be retained to mean these specific substances. The word "alum" should not be used in the sense of either.

What is the reason for asking for an extension for the meaning of the word?

No valid reason has been assigned. The only argument has been that it is sometimes so used by unauthorized persons—but it is not so used by chemists who are the final arbiters of chemical language.

Everything favors the retention of the present sense of "alum" and "the alums."

CONCLUSIONS

1. The Latin word ALUMEN denoted astringent brines and substances containing or composed of aluminium sulphate, iron sulphate, alkaline salts and also alum $(K_2Al_2\ (SO_4)_4.24H_2O$.

2. In late Roman times and during the middle ages the word *alumen* signified a purified and crystalline product made from such mineral crude materials. The "ice alum" of Geber and the later alchemists was undoubtedly crystalline potassium alum.

3. The ancient significance may have attached to the English word ALUM during its early history but in all liklihood it was applied more and more to potassium alum and sometimes to ammonium alum.

4. After the middle ages and down to the present time potassium alum has been on the whole the principal member of the alum group, although at times ammonium alum has had extensive use. Both have been called "alum" "common alum" "ordinary alum" in some works of reference, but the term ALUM unqualified has been more frequently applied to potassium alum than to ammonium alum.

5. In modern times and in particular during the past fifty years, potassium alum has been the common alum of commerce, with the exception of a short period during the late war. In the great majority of chemical text books and other works of reference, including

standard and medical dictionaries, the word ALUM unqualified means potassium alum ($K_2Al_2(SO_4)_4$-$24H_2O$).

6. The term ALUM has been extended in a technical sense by chemists to include the entire group of alums, being compounds of the same crystalline form as common alum and of analogous chemical structure. In this group of alums the potassium may be replaced by another metal or base and even the aluminium also as by chromium or iron.

7. Aluminium sulphate has come into increasing use in recent years for water purification, dyeing, tanning, paper-making, etc. as a substitute for alum, and in trade jargon and shop-talk has frequently been called "alum." This misuse of the word ALUM to cover aluminium sulphate has resulted in a confusion of terms but the practice has never become general and indeed the majority of persons using the word ALUM in place of aluminium sulphate are well acquainted with the fact that they are using an incorrect word.

8. Sodium aluminium sulphate (S. A. S.) as used in the baking powder industry can neither be considered "alum" or an alum. It is properly designated as sodium aluminium sulphate.

9. The use of the term ALUM without qualification to mean S. A. S. in baking powder is misleading. It is not alum or an alum and not only no misrepresentation but clarity results from calling it by its right name, sodium aluminium sulphate.

DEFINITION OF "ALUM"

The present definition of alum as given in Webster's New International Dictionary is correct and satisfactory. Alum and Aluminium Sluphate are defined as follows—

ALUM—Ref. Webster's New International Dictionary. Springfield, Mass. G. & C. Merriam Co. 1914, Page 65.

ALUM (al'um), n. (ME. *alum, alom,* OF. *alum,* F. *alun,* fr. L. *alumen* alum.) 1. Sulphate of potassium and aluminium, $KAl(SO_4)_2 12H_2O$, crystallizing ordinarily in beautiful colorless octahedrons;—called specif. *potash* alum, or potassium alum. It has an astringent taste. Alum has various uses in the arts, and is employed in medicine especially as a styptic and astringent. See Aluminium Sulphate.

2. *Chem.* Any of a series of double sulphates isomorphous with common alum, in which the potassium may be replaced by sodium, ammonium, etc., and the aluminium by iron, chromium, or some other trivalent metal. Ammonium aluminium sulphate, or *ammonia alum,* very closely resembles potassium alum, and is often sold as *alum.*

ALUMINIUM SULPHATE. *Chem.* A salt, $Al_2(SO_4)_3$, forming colorless monoclinic crystals which contain 18 molecules of water,—called also *concentrated alum.* It occurs native as alunogen and is prepared artificially, by treating the hydroxide with sulphuric acid. It is used in dyeing as a mordant, in purifying water, in tawing skins, etc., having largely replaced alum for these purposes.

In order to give recognition to the fact that the term ''alum'' has been improperly applied to aluminium sulphate in trade jargon, a note to this effect should be inserted under the definitions both of alum and aluminium sulphate. The definitions would then read as follows:

ALUM (al'um), n. (ME. *alum, alon,* OF. *alum,* F. *Alun,* fr. L. *alumen* alum.) 1. sulphate of potassium and aluminium, $(KAl\ SO_4)_2.12H_2O$, crystallizing ordinarily in beautiful colorless octahedrons,—called specif. *potash alum,* or *potassium alum.* It has an astringent taste. Alum has various uses in the arts, and is employed in medicine especially as a styptic and astringent. *Incorrectly applied to Aluminium Sulphate.* See Aluminium Sulphate.

2. Chem. Any of a series of double sulphates isomorphous with common alum, in which the potassium may be replaced by sodium, ammonium, etc., and the aluminium by iron, chromium, or some other trivalent metal. Ammonium aluminium sulphate, or *ammonia alum,* very closely resembles potassium alum, and is often sold as alum.

ALUMINIUM SULPHATE. Chem. A Salt, $Al_2(SO_4)_3$. forming colorless monoclinic crystals which contain 18 molecules of water;—called also *concentrated alum. Sometimes erroneously called alum.* It occurs native as alunogen and is prepared artificially by treating the hydroxide with sulphuric acid. It is used in dyeing as a mordant, in purifying water, in tawing skins, etc. having largely replaced alum for these purposes.

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These references have been prepared from citations to the literature prepared by Dr. E. E. Smith, Austin M. Patterson and W. D. Richardson.

These citations have been classified as

1. General Literature
2. Industrial Literature
3. Chemical Literature
4. Medical Literature

The publications are arranged under these heads in chronological order with dates attached.

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